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Comparing CMIP5 and CMIP3 for the Pacific Northwest

Overview:
Recently, climate projections from the 5th phase of The Coupled Model Intercomparison Project (CMIP5) have become available. A key change from CMIP3 to CMIP5 is the change in scenarios of projected greenhouse gas concentrations during the 21st century. Other notable advancements from CMIP3 to CMIP5 include finer spatial resolution, the prescription of land use change (past and future), and, for some global climate models, simulations of the *carbon cycle and atmospheric chemistry*. CMIP5 model runs indicate a warmer future in the Pacific Northwest (PNW) than those from CMIP3, while both modeling experiments suggest a slightly wetter future.

Assumptions about Future Greenhouse Gases:
A key difference between CMIP3 and CMIP5 is the set of emissions scenarios that drive or 'force' the simulations of future PNW climate (Fig 1). The CMIP3 simulations of the 21st century were forced with emissions scenarios from the Special Report on Emissions Scenarios (**SRES**)[1]. The CMIP5 simulations of the 21st century are driven by "representative concentration pathways" (**RCPs**)[2]. The RCPs do not define emissions, but instead define *concentrations* of greenhouse gases, aerosols, and chemically active gases. RCPS represent and encompass the range of current estimates regarding the evolution of radiative forcing – the total amount of extra energy entering the climate system - throughout the 21st century and beyond.

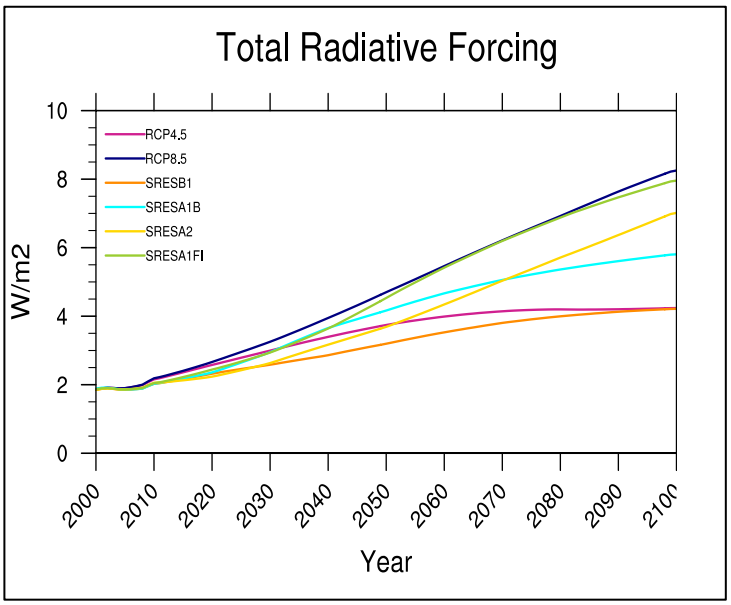

Figure 1: Approximate total radiative forcing from SRES B1, A1B, A2, A1F1, and RCP4.5 and 8.5 scenarios (source: live.magicc.org).

The CMIP3 scenarios shown in Fig 1 are SRES B1, A1B, A2 and A1F1, listed here in order of low to high emissions. These scenarios represent futures with different combinations of global population growth, and policies related to alternative energy systems and conventional fossil fuel sources[1]. Unlike the SRES scenarios used in CMIP3, *RCPs do not assume any particular climate policy actions*. Instead, policy analysts and social scientists are free to develop mitigation scenarios that lead to one of the RCPs. The CMIP5 climate scenarios considered here use RCP4.5 and RCP8.5, which represent increases in radiative forcing to roughly 4.5 W/m^2 and 8.5 W/m^2 above pre-industrial levels by the year 2100.

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Comparing CMIP5 and CMIP3 on Modeled Temperature and Precipitation:

Model Evaluation: Both CMIP3 and CMIP5 models reproduce many characteristics of PNW US climate fairly well including the observed PNW seasonal cycle of wet winters and dry summers, the observed 20th century PNW warming trend (~0.8°C/century), and observed annual temperature. However, both CMIP3 and CMIP5 models are generally too wet on an annual basis compared with observations[3,4].

Temperature (Fig 2a): The CMIP5 climate scenarios based on RCP4.5 and RCP8.5 are warmer for the PNW, on average, than the CMIP3 scenarios based on SRES-B1 and SRES-A2. In this example, most of this difference can be explained through increased forcing between these two sets of emissions/concentration scenarios.

Precipitation (Fig 2b): In the case of precipitation, both the representative CMIP3 and CMIP5 scenarios show a slightly wetter PNW future on average by mid 21st century . The seasonal pattern of change in CMIP3 of slightly drier summers with slightly wetter conditions the rest of the year is also present in CMIP5. Overall, the relatively large natural variability of precipitation compared to the greenhouse gas response effectively masks any differences between CMIP3 and CMIP5 at this level of analysis.

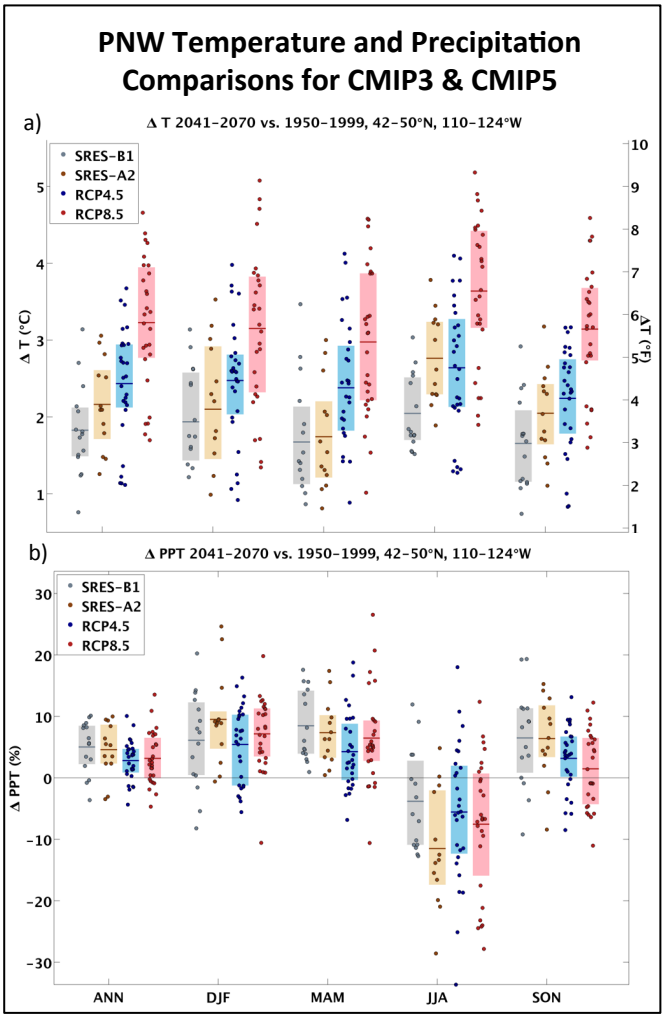

Figure 2: Changes in annual mean and seasonal a) temperature and b) precipitation (2041–2070 minus 1950–1999) averaged across the Northwest, calculated from CMIP3- SRES and CMIP5-RCP simulations. Each symbol represents one simulation by one model (where more than one simulation is available, only the first is shown), and the shaded boxes indicate the interquartile range (25th to 75th percentiles). Means are indicated by thick horizontal lines in the boxes[5].

References:

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